Made for China: Transcoding Local Patterns into Ecologically High-Performing Urban Prototypes

MONA EL KHAFIF
California College of the Arts

ANTJE STEINMULLER
California College of the Arts

INTRODUCTION

Described as a "dystopian vision of instant urbanism on steroids"[1] , generic high-rise housing is erected on the razed ground of formerly vibrant neighborhoods in China, displacing and dispersing communities into self-contained, homogeneous bedroom developments on the periphery, and producing a highly fragmented urban landscape. 400 new cities are planned to be built between 2006 and 2020, increasing the country's urbanization rate to an expected 60%. While these rapidly built, large-scale developments have turned China into an exciting laboratory for contemporary urban and architectural ideas, the country is already the world's largest waste generator, and one of the largest consumers of water[2]. This paper explores alternatives to the razing of existing patterns of living in China, and proposes a method of extracting and transforming 'local code' from the adjacent context of new developments - a code that is hybridized with much needed ecological strategies as a way of alleviating environmental issues, such as water shortages, from the bottom up.

With MADE FOR CHINA, we describe a general framework within which new ecological rule sets can be embedded with local specificity as an alternative approach to conventional masterplans. This paper draws from design research developed via an advanced elective studio in CCA Architecture's URBANlabon the production of new urban prototypes for the fragmented context of Tianjin, China. It is based on a case study for an integrated set of visualization methods and computational tools that look to redefine urban design methodology in the dialog of local and global in hyper-urbanized China. Addressing the uncritical import of western paradigms into the Chinese context, the research work is based on *decoding* local conditions within the Chinese context, including population changes and circulation patterns as well as spatial and programmatic parameters. The main focus is on the development of new urban and architectural typologies capable of synthesizing local patterns with global concerns for environmental performance. This includes the design of active "blue, green and yellow layers" such as grey water recycling, food and energy production that evolve locally specific strategies into ecologically high-performing typologies with flexibility and high density.

In-depth research and visualization of current paradigm shifts in China, specifically in the city of Tianjin, form the departure point of the proposed

methodology. Data sets related to politics, urban growth, economy, demographics, environment, climate and transportation are translated into analytical and projective datascapes and infographics that provide critical background information for the subsequent phases to draw from. These infographics serve to visualize the dramatic developments of recent years and seek to project the progression of these developments into near future. The design methodology itself employs three interlinked phases - *decoding*, *transcoding* and *recoding*. We begin with an investigation into site-specific morphology, extracting local urban parameters such as spatial rhythm, program, density, and critically, green spaces, solar performance and water consumption (*decoding*). Based on the initial research, we are able to establish new ecological rule sets that hybridize the local 'urban code' with specific ecological performance (*transcoding*). A final *recoding* phase enables testing and optimization of the ecological and spatial performance parameters as they develop into new urban adaptive prototypes for future cities – inside and outside of China.

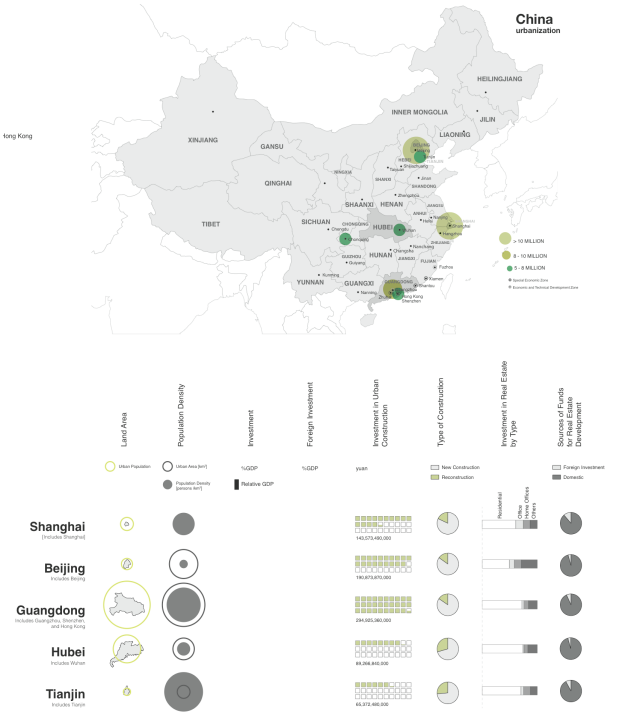

Figure 2. Urban Growth Infographics

BACKGROUND

Fragmentation and Imported Paradigms

Urbanization in China is taking place at an unprecedented speed. Sparked in part by the designation of Special Economic Zones (SEZ), argued to be China's greatest contemporary urban invention[3], industry-driven urban growth has completely altered the face of Chinese cities. Infographics from our initial research phase show the sudden migration-triggered population growth and its effect on the construction industry (figures 1+2).

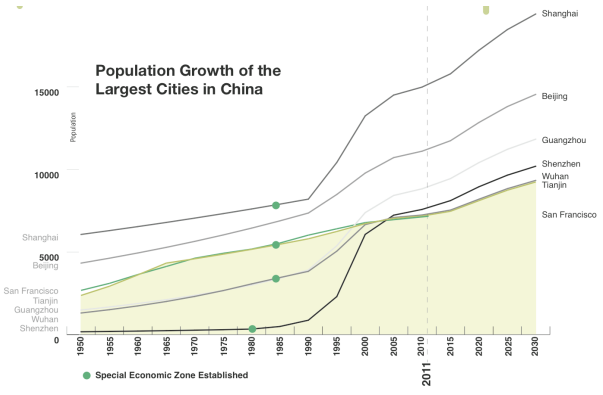

Figure 1. SEZ-triggered Growth

As the portion of the population living in urban centers approaches 50% this year[4], the razed ground of many formerly vibrant inner-city neighborhoods now displays a collection of iconic towers modeled uncritically after Western paradigms without consideration of the urban space produced in the process. Neville Mars and others have commented on the hyper-meticulous design[5] of individual component parts within the urban environment without giving consideration to the whole these parts add up to – the urban space, now the unintentional consequence of individual interventions without spatial continuity. In Tianjin, the recent completion of the Tianjin Global Financial Center serves as an example for another carefully designed figure added to the skyline at the river front. Its iconic presence has already made it a landmark for the city, yet at the base of the tower, a large formal plaza creates an uncomfortable void in the urban context, creating a separation between the dense residential fabric and the Haihe River. While the building was much lauded for efficient application of steel plate shear walls reducing the overall material use significantly, its performance in the surrounding urban space, as with so many buildings of its kind, is underdeveloped.

Other urban areas re-emerge as modern-day versions of the Plan Voisin - generic towers in self-contained homogeneous bedroom developments in the form of "themed" gated communities. Such developments often occur under the pressure of solving fast population migration-triggered growth, or are a consequence of a hurried striving for modernization, borrowing cookie-cutter approaches imported from elsewhere. As inner city areas get redeveloped in this form, the government's approach to the existing city fabric ranges from tabula rasa to the occasional preservationist approach, more often than not rebuilding from scratch a sanitized version of the historic as a tourist attraction. In Tianjin, almost the entire area of the historic old city was razed only recently, between 2000 and 2004, and has since been replaced with residential high-rise communities. Two of the original streets were re-built as a tourist destination, lined with a disney-esque version of the old historic core. In the process of such redevelopment, vibrant communities are pushed out of the inner city and dispersed into new developments elsewhere.

Through the absence of consideration for a coherent, vibrant urban space, the iconic towers and gated high-rise compounds with their manicured lawns and plazas have produced a highly fragmented urban landscape devoid of habitable urban space. The growing popularity of cars has further broken up many cities: streets are widened to accommodate the increasingly heavy traffic, many are 10-12 lanes wide and only crossable at widely spaced intersections and overpasses. Research conducted throughout the first phase of the studio tracked the rise of automobiles in recent years, and projected 1.1 billion cars if US patterns of car ownership were adopted (figure 3).

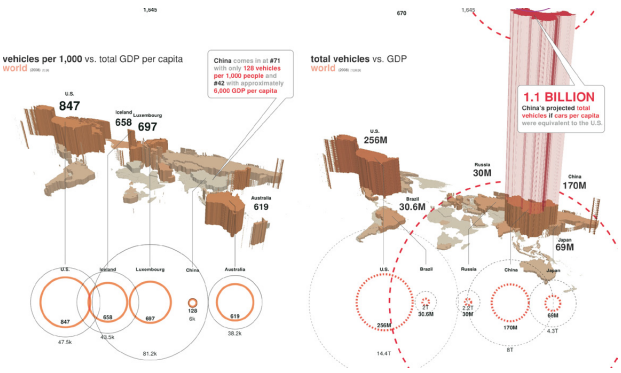

Figure 3. Transportation Datascapes

Rapid Growth and Shrinking Water

In the process of building approximately 21.5 billion sf per year, China uses 26% of the worlds crude steel, and 47 % of the world's cement[6]. The speed and intensity of urban development has brought with it a host of environmental problems, from the pollution of rivers and the disappearance of arable land to acute water shortages. The Haihe River in Tianjin - China's third Special Economic Zone and the sixth largest city in China - is one of the most polluted river basins in China. The region has only 16% of the country's average per capita water resources.

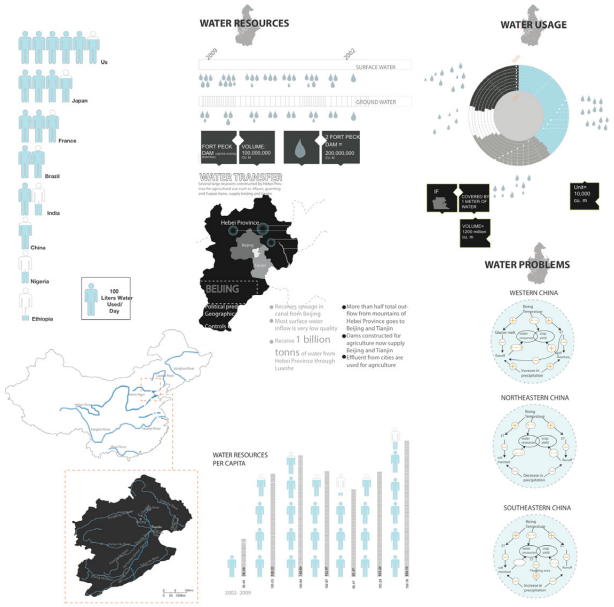

Figure 4. Water Infographics

Overexploitation of groundwater upstream, deteriorating water quality due to proximity of heavy industry, and growing demand for water driven by the region's population increase have led to significant water-related environmental issues. Confronted with acute water shortages, the government is now looking beyond multi-decade infrastructure projects like the South North Water Transfer Project, towards more local strategies for sustainable urban water resource management[7]. The research phase of our project included examining comparative and changing availability of water resources, water usage distribution, and projected rain harvest and daily average water consumption (figure

4) in preparation for engaging bottom-up strategies for dealing with the water issues of the region. With the MADE FOR CHINA project, we argue that both the issue of the fragmentation of urban space through imported Western typologies, and environmental problems arising from the rapid growth require a novel, integrated approach to urban design. We developed a framework that hybridizes much needed ecological rule sets with a local code derived from identifying spatial, environmental and programmatic parameters within the city context. The proposed methodology of *decoding*, *transcoding* and *recoding* extracts, transforms, and extends these local parameters into new urban prototypes that link the fragmented city into a sustainable and vital urban landscape. Building on the background research and data visualization, our approach begins with a detailed understanding of parameters that constitute this local code - to be hybridized with ecological strategies in the later phases.

DECODING / TRANSCODING / RECODING

Specific Site Context

The city of Tianjin developed as a former treaty port, a gateway to the capital city of Beijing 70 miles upriver. The area under investigation for this research was the former British concession, an area called Wudadao (figure 5) - one of nine foreign concessions with their own very distinct character that fragmented the city during its time as a treaty port. Wudadao, with its small-scale fabric and green spaces at various scales is an outpost of a British Garden City in China. It is now considered a tourist destination, and the government is looking to preserve the district's unique identity. Wudadao is surrounded by higher density developments, and an area of 75 ha at the edge of the district is now slated for redevelopment. It is zoned to transition from the average Wudadao building height of 3-4 stories to about 100 ft. Bordering Wudadao to the northeast is a 10-lane thoroughfare built on a filled-in canal, now flanked by high-rise development.

The edge of Wudadao along this thoroughfare was chosen as the location for this research project. Its character as an edge condition of an older city district, as well as the much higher density required, made it an ideal test site for recalibrating and transforming parameters derived from the existing urban fabric into a new urban code that produces

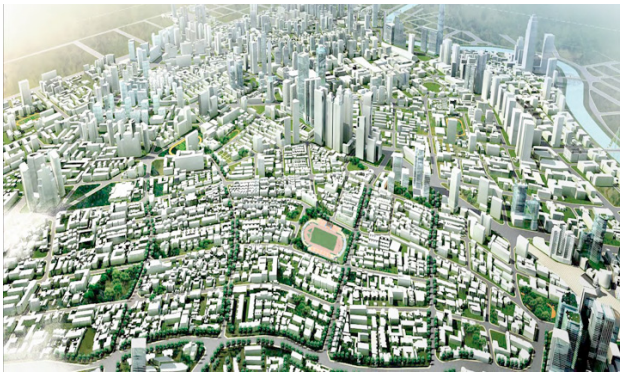

Figure 5. Wudadao Model

an ecologically active urban landscape, and links the disjointed city fabric at the district edge. The conceptual approach to the site envisioned a novel and much denser three-dimensional garden city – a contemporary ecological version of Wudadao.

Local Identity and Global Challenges

The context of the case study combines local and global challenges. On the one hand, Tianjin - as most of new urban China - is suffering from a lack of horizontal continuity, causing fragmentation as well as a loss of local identity, and on the other hand, water scarcity, global climate change and the need of renewable energy resources are calling for a radical re-conceptualization of how we design city fabrics. Stefano Boeri[8] articulated five ecological challenges facing contemporary cities for the Expo 2015 and suggested an inverted model of urban metabolism: Rather than consuming water, energy and land, the city of the future—understood as an ecological system—needs to produce those resources. As Boeri states, the concept of collector-buildings that gather solar energy and wind is not new. The integration of ecologically active building masses to generate new urban typologies that absorb and conserve the energy they need, however, is a new approach that would be beneficial to the high-speed urbanization of China's cities. As discussed in Moshen Mostafavi's *Ecological Urbanism*[9] much of the sustainability-oriented work undertaken by architects has been dedicated to the building scale. While LEED certifications as the current response to the global ecological challenges are still reduced to the individual object, a systematic approach to the urban scale - facing issues of rapid urbanization and limited global resources - is still a field of urban research under development.

Decoding: Understanding Local Identity as Spatial Conditions and Typologies

The urban analysis of the test site in Tianjin started with the *decoding* of valuable spatial components of the Chinese city. Later, these will be *transcoded* by embedding environmental parameters, and then *recoded* into new urban typologies that are now related to local, historic genetics of the context and also implement contemporary requirements such as environmental performance. The decoded local urban parameters can be described as density, program distribution, block circulation, rhythm of grain and grid. The framework for this form of analysis originated in a program entitled *URBANbuild*[10], developed for the rehabilitation and regeneration of New Orleans post hurricane Katrina. In parallel, an input-output model as demonstrated in *Ecodesign*[11] evaluated the resulting urban metabolism in relationship to population density. In addition, a context-related strategic urban masterplan was developed in order to secure the spatial connectivity among urban blocks, street layout, building heights, land use, and public spaces.

Rhythm, Grid Grain and Circulation

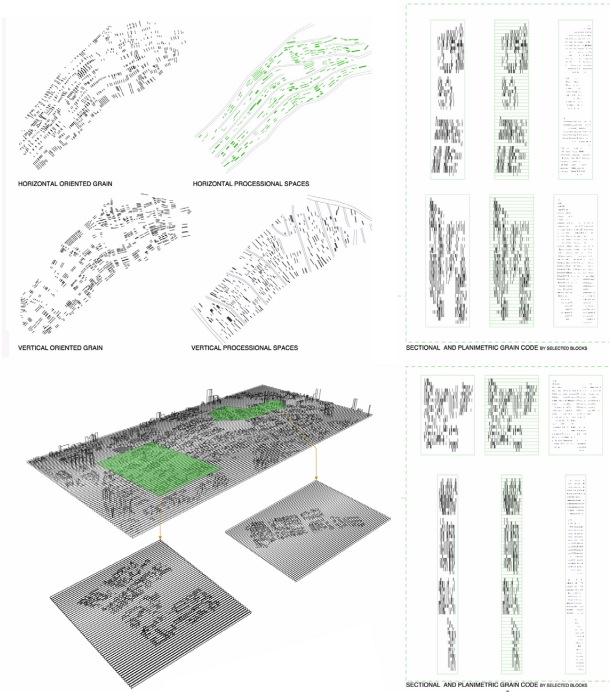

Figure 6. Grain Analysis

Figure 7. Wudadao Fabric

Figure 8. Wudadao Alleyways

A series of urban blocks was analyzed starting with aerial photographs and figure-ground analysis that produced a pixilated reading of the urban footprint of each block (figure 9). Similar to the fabric of historic Chinese walled cities, Wudadao's fabric and grain consists of an adaptive system of architectural typologies organized as an open field of buildings within the city blocks (figure 6). Unlike American or European city blocks, this fabric does not include a clear separation between public and private defined through a perimeter condition, but articulates a system of aggregated typologies that allow an internal circulation through alleyways and a mix of building types (figure 7). Even though the historic Chinese city followed a clear north-south orientation in order to protect housing from north winds and evil spirits, Wudadao's fabric is a hybrid, highly influenced

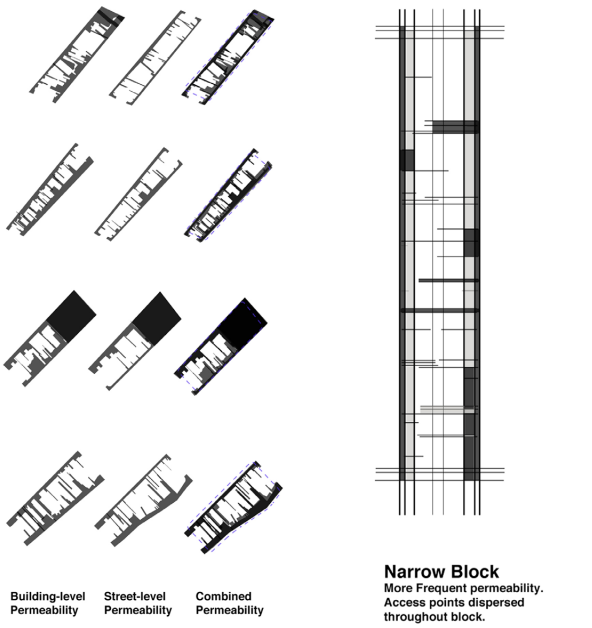

Figure 9. Circulation Systems (Maps and superimposed Matrix)

by the concept of the imported British Garden City. Traditional elements like alleyways (Hutongs) that form passages between the courtyards (Siheyuans) remain present in altered form, giving Wudadao its specific local identity. Through the analysis we were able to decode a dimension of 10'x45', a 'pixel' that defined the smallest width of a circulation element internal to the block, and that aggregates to generate the larger dimensions for housing units and courtyard spaces. The 'grain' [12], as a delaminated directional component of the built texture, and the 'grid', as a system of larger urban structures, show a relationship to the street layout, but create a field of non-hierarchical patterns with shifted rhythms. The alleyways perforate the seemingly accidental aggregation of typologies through the short dimension of the block (figure 9). They often feed into semi-private micro-plazas that are located within the city blocks and form common spaces for the neighborhood. The block – understood as a field – contains a social substructure of micro-neighborhoods generated by the circulation system (figure 8).

Density and Green Spaces

While the current edge of Wudadao is found to be a collection of disconnected buildings, further fragmented through the introduction of generic high-rise types, the historical part of Wudadao's core can be read as a field condition of different aggregated densities. The urban fabric itself is most legible through its mix of densities (FAR) that bridge from low, to medium and high density within each city block (figure 10). The datascape in figure 7 was used to analyze six historical city blocks in Wudadao with a density and void rhythm described by varying percentages: all selected blocks show an

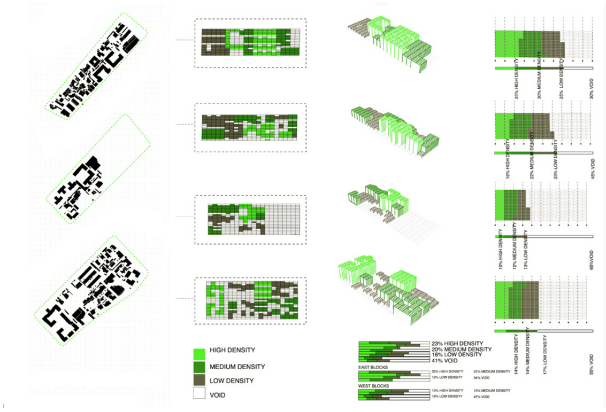

Figure 10. Density Datascape Urban Decoding with included Percentages

Figure 11. Green Space Analysis (Maps and Bar Diagrams)

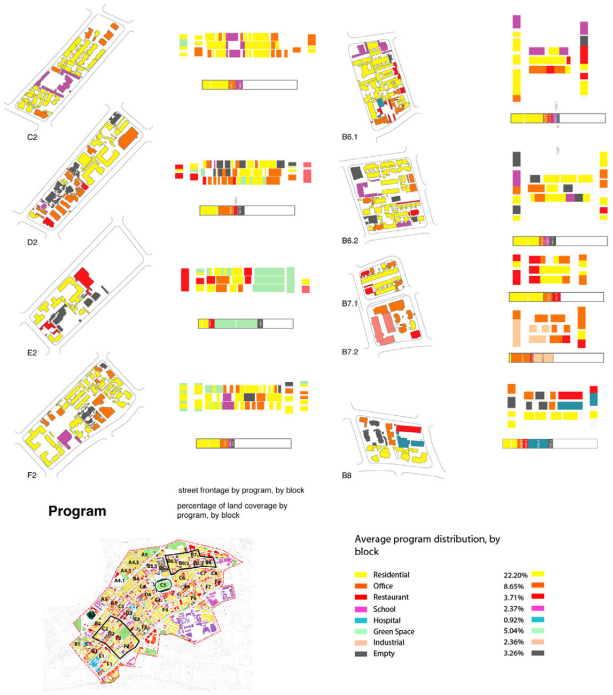

Figure 12. Land Use Analysis (Maps and Diagrams of sample Blocks)

Figure 13. Flexibility of Space

average of 23% high-density, 20% medium-density, 16% low-density and with a remaining 41% void space. The void often consists of circulation elements that articulate a similarly diverse palette of micro-greenspaces, small-scale pocket parks, internal boulevards and courtyards. By taking multiple sections through the block, the bar diagram captures the changing condition of green space distribution and typologies (figure 11).

Program Distribution and Activities

Following the concept of field rather than perimeter condition, the program distribution does not clearly separate public and private programs, though larger urban elements like commercial corridors can be identified. Public program occurs within city blocks while residential program is also located along the outer street network (figure 12). Courtyards operate as flexible extension zones for small-scale business and garages or cellar spaces often transform into bakeries and other local businesses. The neighborhood seems to be characterized by programmatic diversity and flexibility, often enriched through mobile programs (figure 13).

The analysis unveils spatial conditions that are unique to Wudadao's historic fabric and urban identity – its specific *local code*. A field condition of diverse housing typologies and densities is built on a modular pixel of 10'x45' and perforated by semi-public circulation systems that establish micro-communities within the city block. Programmatic flexibility, a diverse articulation of common spaces, from public to private, and spatial shifts within the grain can clearly be identified as a spatial support of local life and cultural identity.

Transcoding: Urban Metabolism and Ezone Parameters

In an effort to optimize the environmental performance of the envisioned development on the test site, this second phase of the design methodology combines extracted *local codes* with a mandate to integrate ecological parameters: a process causing a transformation of the existing local code – *transcoding* - towards more sustainable performance. Based on calculations of energy and water consumption per inhabitant for a given block, the proposed block zoning requires appropriately sized rainwater catchments and gray water recycling to occur on site. Additionally, the new zoning also requires energy generation through solar technologies that might allow for potential overproductions. The zoning of blue (water), green (productive green spaces) and yellow (solar) environmental performances of a given block is titled Ezone (Environmental Zoning). In order to transform the tra-

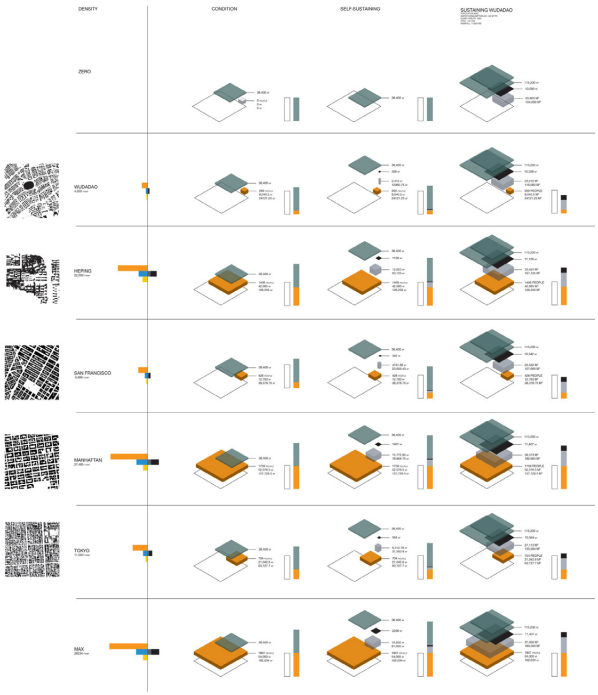

Figure 14. Sustainable Levels required for given Population

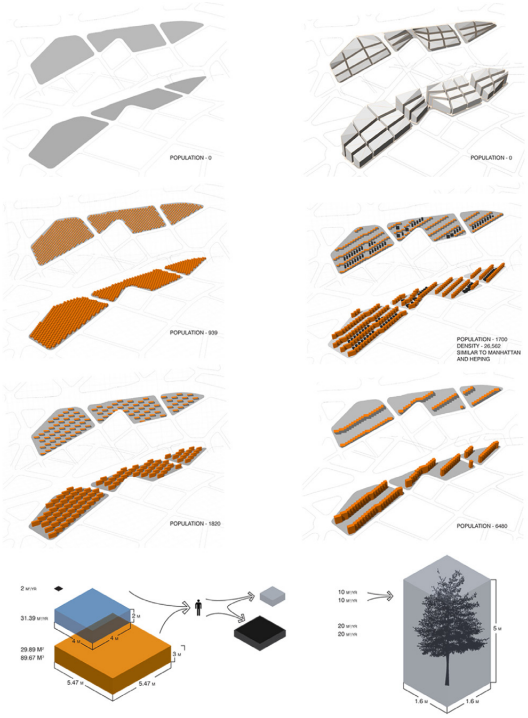

Figure 15. Population Footprint and Site Sustainability Index

ditional metabolism of consuming urban systems into self-sufficient or over-producing city blocks, Ezone requires a pre-defined ecological performance of the site. Depending on local climatic conditions (rain fall, solar orientation), population density and consumption patterns (water and energy), the combined code will guarantee a capacity of the block to both harvest and preserve resources.

The datascapes show different environmental performances for the test site in Tianjin, assuming self-sufficiency, over- or underproduction in relation to different populations densities. Working with the blue (water), yellow (solar energy), and green (greywater gardens, rendered in grey in this figure) eco-parameters, the data sets provide a matrix with different scenarios for future typologies (figure 14).

Working with the current statistics, a person in China produces 30% black and 70% greywater which translates into 58 liters of greywater a day equaling 406 liters per week. This water can be used for irrigation instead of fresh water and can also be recycled back into the system. Based on the local water consumption data, a greywater garden that recycles greywater in order to feed it back into the system requires a 2.6 sqm footprint and a height of 5 meters. The datascape below illustrates how much 'active' green space of this kind is required per person given a specific population. The water-recycling footprint is supported through the collection of rainwater on all flat roofs that feed water through the gray water gardens into water storage elements.

A similar calculation can be made for solar energy harvesting. Given the location of the site and its yearly solar radiation it can be assumed that a 2 sqm footprint solar surface equipped with the latest technology can produce the energy required for hot water and heating per person. An overproduction would allow future typologies to feed energy back into the city grid. The average energy consumption per person in China was 875 kgoe in 2000 and 1,316 in 2005 [13] showing how important the onsite energy production will be in the future. A parametric model developed in this research allows for a synthesis of the eco-parameters integrated into the development of new typologies. The scripting method used also supported the testing of different scenarios and potential futures (figure 15).

Recoding: Prototyping According to New Urban Rule Sets

As the extracted urban parameters are *transcoded* into rule sets that consider both environmental performance, and local spatial patterns (of density, programmatic mix, urban circulation typologies, etc.), a cross-breeding of essential characteristics of the specific surrounding urban condition with new requirements for solar energy production and grey water recycling can occur. In the context of current Chinese hyper-urbanization, in which isolated imported high-rise typologies replace the rapidly disappearing older fabric, this poses a radical departure from the paradigm.

Integrating the parameters of the derived rule sets into Grasshopper scripts enables a design process in which form-finding is intricately linked to testing performance within the specific environmental framework established at an urban scale. The development of urban typologies within the computational model requires the integration of local codes (modular aggregate, three dimensional public circulation systems, programmatic flexibility) and eco-parameters (integration of blue, yellow and green pixels per unit and micro-community). Through a prototyping process, a series of test projects can be developed to evaluate the eco-performance of the resulting fabric in relationship to population densities and local context.

As parameters are changed within the matrix in order to play out different eco performances, rapid prototyping becomes the process of iteratively examining the capacity of potential typologies to fulfill the environmental demands of the strategic masterplans. Understanding performance and limitations in the prototypes thus enables the production of new typological hybrids in which the desired environmental and spatial performance is optimized. As individual projects are developed at an architectural scale, the scripts are augmented and altered based on increasingly specific programmatic and spatial information. In the context of a performance-driven urban strategy, both the transformation of the local code and the new environmental rule sets find an optimized physical-spatial translation at the block and building scale. Using the example of the density code extracted from the Wudadao fabric, the local code identified a modular system based on the 10'x45' "pixel", embedded with information on different densities of built as well as open space. In this phase, the void pixels were embedded with specific ecological performance parameters that redefined their relationship, as well as the overall ratio of built to void pixels, according to the higher overall density required for the test site (figure 16).

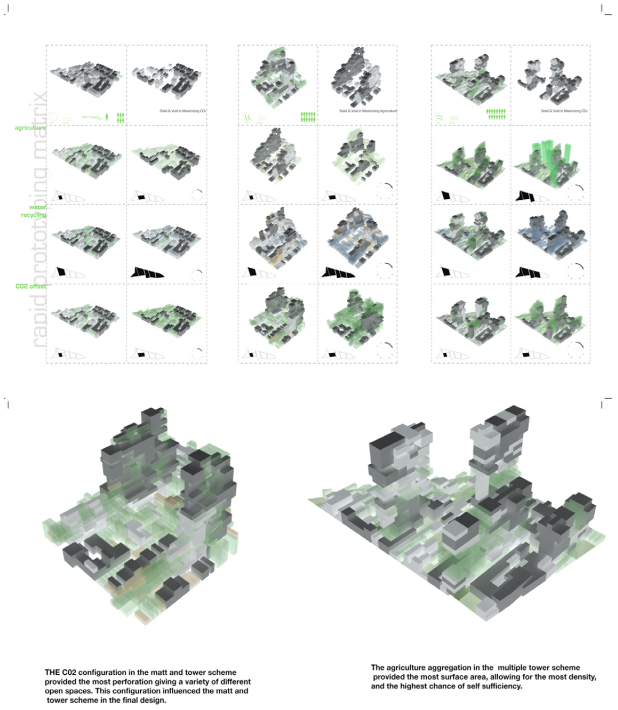

Figure 16. Computational Matrixes of Prototypes CIDEmax

As a result, the recoding phase produced an understanding of the spatial consequences and limitations of self-sufficient urban metabolisms. In this process, the coupling between population density (consumption) and Ezone (production) with local spatial parameters allowed for the development of a systematic approach towards a more sustainable fabric. In addition, the integration of Ezones is supporting a renaissance of the local identity: a three-dimensional garden city that allows the establishment of local culture and life as described above.

ASSESSMENT AND IMPLICATIONS

Traditional masterplans define heights, land use and density (FAR) on individual lots or blocks. China requires additional parameters for building

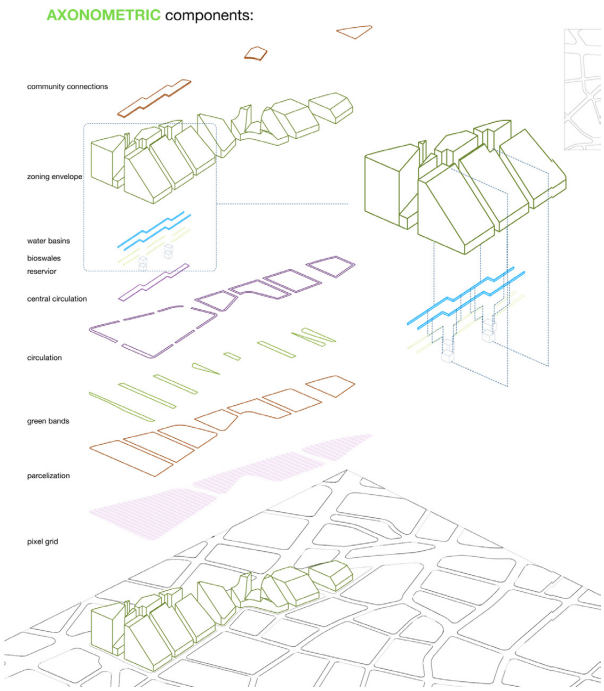

Figure 17. CIDE max (Community, Identity, Density, Ecology) final Prototypes (Urban Framework)

life cycles (70 year land lease for residential, 40 years for commercial) and light access depending on land use (2 hours minimum of light access on January 21st for housing). The urban rule sets established through the method described above integrate a performance-based zoning that include environmental parameters while also requesting a response to the local typologies and cultural identity. The strategy we present brings light to relationships between building massing, building envelope configuration, and ecological performance, articulating performance-based design for new ecological zoning. The resulting architectural typology can be evaluated according to its embedded codes that are specific in reference to ecology, but also in reference to physical structures of the context to ensure continuity (figure 17-20).

Current self-critical discussions within the theories of urbanism radically call for alternative approaches that cross scales and address the urban in its cultural, economical and ecological complexity. Within this context, MADE FOR CHINA tries to respond to the challenges of global climate change while simultaneously attempting to retain the typological codes of Wudadao's local cultural identity.

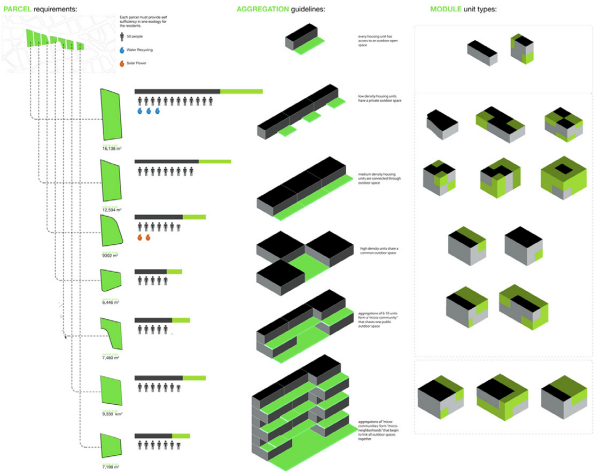

Figure 18. CIDE max (Parcel Ezone, Aggregation, Unit Types)

Figure 19. CIDE max (Rendering)

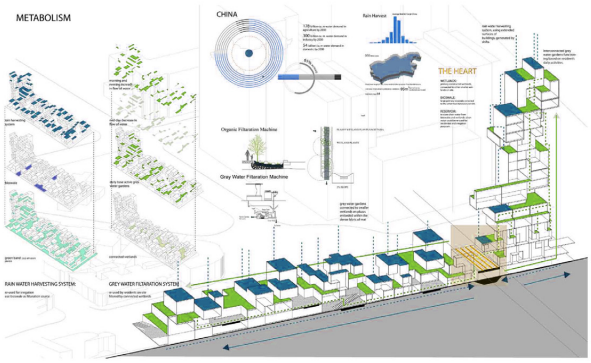

Figure 20. CIDE max (Metabolism)

CREDITS

Figure 1: SEZ Population Growth, Student Work: Ellen Anderson, Audrey Galo

Figure 2: Urbanization Infographics, Student Work: Ellen Anderson, Audrey Galo

Figure 3: Transportation Datascapes, Student Work: Jeremy Bamberger, Alexandra Spautz, Pranay Mowji

Figure 4: Student Work: Souzan Kachabi, Salar Moazzensafaei

Figure 5: Image credits: Tianjin Urban Planning and Design Institute

Figure 6: Student Work: Souzan Kachabi, Salar Moazzensafaei, Alexandra Spautz

Figure 7: Image Credits: Mona El Khafif

Figure 8: Image Credits: Mona El Khafif

Figure 9: Student Work: Jeremy Bamberger, Ellen Anderson, Sharon Nguyen

Figure 10: Student Work: Souzan Kachabi, Salar Moazzensafaei, Alexandra Spautz

Figure 11: Student Work: Souzan Kachabi, Salar Moazzensafaei, Alexandra Spautz

Figure 12: Student Work: Jeremy Bamberger, Ellen Anderson, Sharon Nguyen

Figure 13: Image Credits: Mona El Khafif

Figure 14: Student Work: Erin Avera, Arun Bisessar

Figure 15: Student Work: Erin Avera, Arun Bisessar

Figure 16: CIDE max, Student Work: Souzan Kachabi, Salar Moazzensafaei, Pranay Mowji

Figure 17: CIDE max, Student Work: Souzan Kachabi, Salar Moazzensafaei, Pranay Mowji

Figure 18: CIDE max, Student Work: Souzan Kachabi, Salar Moazzensafaei, Pranay Mowji

Figure 19: CIDE max, Student Work: Souzan Kachabi, Salar Moazzensafaei, Pranay Mowji

Figure 20: CIDE max, Student Work: Souzan Kachabi, Salar Moazzensafaei, Pranay Mowji

REFERENCES

1 Laurence Liauw, "Leaping Forward, Getting Rich Gloriously, and Letting a Hundred Cities Boom" , in *AD: New Urban China*, *Vol.78 No.5* (London: Wiley, 2008), 10.

2 Danish Architecture Center, curators, *Co-Evolution*. (Copenhagen: Danish Architecture Center Publication for the 10th Venice Architecture Biennale), 2006.

3 Laurence Liauw, "Leaping Forward", 7.

4 CIA World Fact Book, accessed 08/30/2011, https://www.cia.gov/library/publications/the-world-factbook/geos/ch.html.

5 Neville Mars, "Monster Metropolis", in *The Chinese Dream: a Society under Construction,* ed. Neville Mars and Adrian Hornsby (Rotterdam: 010 Publishers), 2008.

6 Danish Architecture Center. *Co-Evolution.*

7 Tianjin Municipal People's Government has been at the forefront of developing desalination technology to ensure water supply. International research projects like the 3x3 Partnership Initiative (Beijing Tianjin Water Resource Management Project) contribute finding solutions to address these issues locally.

8 Stefano Boeri, "Five Ecological Challenges for the Contemporary City", in *Ecological Urbanism*, ed. Mohsen Mostafavi and Gareth Doherty, (Harvard University Graduate School of Design: Lars Mueller Publisher, 2010), 444.

9 Mohsen Mostafavi, "Why Ecological Urbanism? Why Now?," in *Ecological Urbanism*, ed. Mohsen Mostafavi and Gareth Doherty, (Harvard University Graduate School of Design, Lars Mueller Publisher, 2010), 13.

10 Ila Berman and Mona El Khafif, *URBANbuild local | global*, (Richmond: William Stout Publisher, 2009)

11 Ken Yeang, *Ecodesign. A Manual for Ecological Design*, (London: John Wiley & Sons, 2008)

12 Ila Berman, "*Scan,*" in *New Orleans. Strategies for a City in Soft Land*, ed. Joan Busquets and Felipe Correa, (Harvard University Press: 2006), 109.

13 International Energy Agency "China v US energy consumption" http://www.guardian.co.uk/business/datablog/2010/aug/03/us-china-energy-consumption-data